OKLAHOMA COOPERATIVE EXTENSION SERVICE NREM-9208

Understanding Streams

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This discussion aims to give landowners the essential information needed to understand how streams work. Further information, including a deeper look at the underlying principles, can be found in the references listed at the end. See the glossary at the end for detailed descriptions of the underlined words.

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What Streams Do

Streams have two mechanical functions. The first is to transport water from higher to lower elevations. The second is to transport sediment - earthen materials better known as rock, sand, silt, and clay. In a healthy stream, the amount of sediment being picked up and moved downstream is equal to the amount being deposited in the stream. In unhealthy streams, this balance is lacking; either too much sediment is being deposited or too much erosion is occurring. Excess deposition is usually indicated by the presence of unstable islands or mid-channel sediment bars. Excess channel erosion is indicated by rapid deepening or widening of the channel. Tell-tale signs are high, freshly eroded banks with exposed roots, or deeply incised channels. Both excess deposition and excess erosion may occur in the same channel reach (Figure 1).

Energy

The movement of water and sediment through a stream system involves kinetic energy. The faster the stream flows, the greater the power it has to erode and carry sediment. As children, many of us played with a flowing garden hose to dig holes in the ground, so we have an intuitive understanding of the cutting power of flowing water. Nature provides four ways of keeping this erosive power in check.

The first way streams protect themselves is the growth of deep or densely rooted, water loving plants along the stream channel. This streamside area is known as the riparian zone (Figure 2). These deep and dense root networks hold the riparian soil together. Although this protective zone of vegetation may be damaged from time to time, one of the great benefits of this network of riparian trees, shrubs and grasses is that it is self-repairing. When some plants are lost, others grow in their place.

The second way streams act to dissipate the erosive energy of flowing water is by changing their pattern or meandering (Figure 3). By forming curves the distance the water travels is increased, the slope is decreased, and the water's velocity slows as a result. It is normal for stream and river channels to slowly move over time. If one could watch a stream from the air over a period of several lifetimes, it would appear as if it were a writhing snake. This is one reason why construction of homes and other structures close to streams should be discouraged.

Figure 1. A high cut bank in the background and a mid-channel sediment bar in the foreground indicate that this stream is out of balance. The undercutting and collapse of streambanks contributes excess sediment to the stream. As that sediment forms mid-channel bars, stream flow is directed against the banks causing more undercutting and collapse. (Photo credit: Mike Smolen)

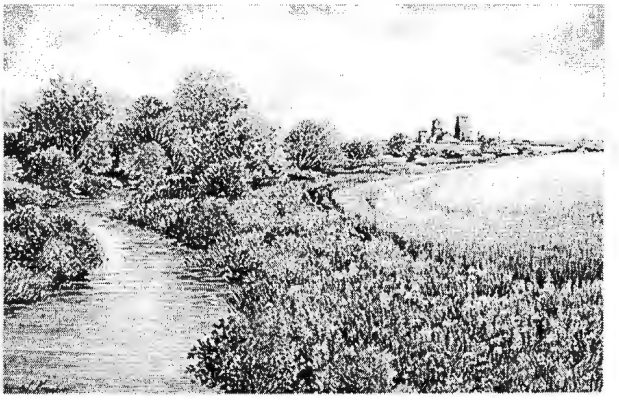

Figure 2. Healthy riparian zones are alive with trees, shrubs or other deep-rooted plants that resist the cutting power of the flowing water and protect streambanks from erosion. (With permission by Wendy Kroeker, artist, and Manitoba Association for Community Arts Councils Inc.)

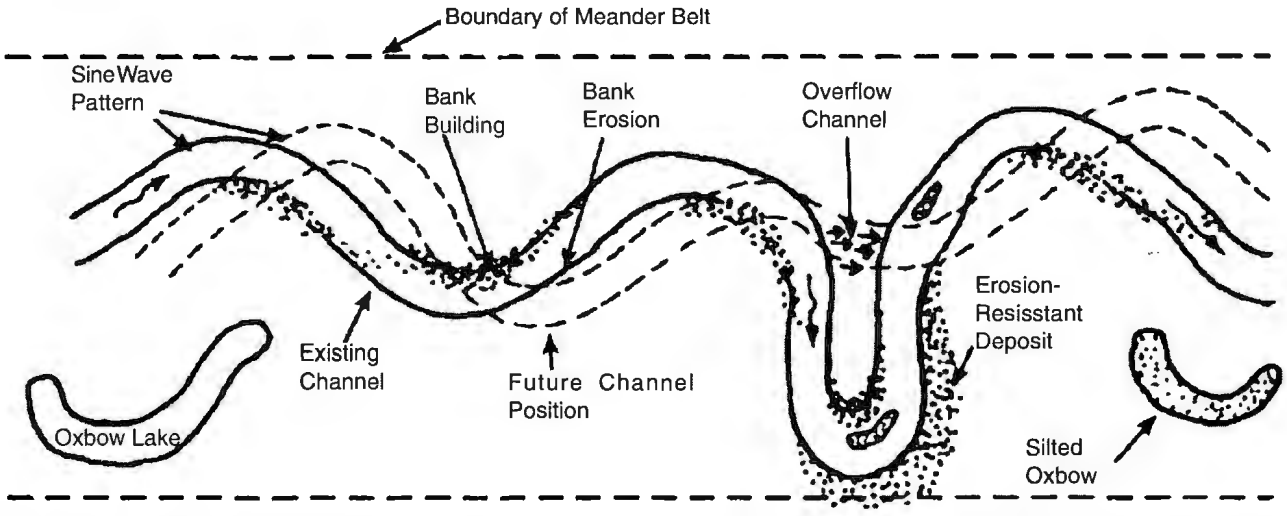

Figure 3. Over time it is normal for a healthy stream channel to move, or meander. Rivers which carry high sediment loads typically develop a braided pattern of multiple crisscrossing channels, instead of the single channel shown here. (Image credit: Ohio Department of Natural Resources)

Flooding is the third way in which erosive energy is reduced (Figure 4). During and after rainstorms, the water rises above the streambank and spreads on the floodplain. The velocity of the water outside the channel is very much reduced and, as a result, sediment is deposited. Flooding is a beneficial process as long as people avoid building houses and other structures in the floodplain. Local groundwater tables benefit from the increased infiltration of water, and the deposition of new sediment helps form and maintain productive soils. Flooding is a natural occurrence and is part of normal stream functioning.

The fourth way of lessening the erosive energy of water is the presence of live trees, plants, rocks, or woody debris within the stream channel, particularly the larger streams and rivers. By increasing the resistance to flow, such objects slow the water's velocity. Down trees, or snags, can also benefit fish populations by creating habitat, such as root wads and scour holes. In smaller streams, down and dead trees may need to be removed to avoid unnecessary flooding. To determine if a logjam or beaver dam should be cleared to maintain flow, seek advice from the Conservation Commission or Department of Wildlife Conservation.

Common Causes of Stream Problems

The failure to understand and respect how nature allows streams to resist erosion can lead to serious problems. While there may be engineering methods for solving these problems, the costs are quite high and almost always beyond the reach of the private landowner. It is far better to understand and respect the ways in which nature regulates stream erosion and avoid such problems (Figure 5).

Figure 4. It is important to recognize floodplains and understand how they work. See "Further Information" for sources of floodplain maps for your area. Always check a floodplain map before buying or building a home or other structure close to a waterway. (Photo credit: USGS)

Figure 5. This high cut bank is the sign of an unhealthy, unraveling stream channel. The channel is being widened as the stream seeks to meander. Once a stream has been degraded this severely, there is little a landowner can do about it. (Photo credit: Mitch Fram)

Along with the benefits of stream ownership, there are some dangers and pitfalls for the uninformed landowner. Whether your stream is a large one that flows year round or a small one that is dry more often than not, take heed of the following warnings:

- **Don't** "clean up" a stream by clearing off the brush, trees and other deep rooted plants from the banks. Their deep root network is all that holds the creek bank together against the cutting power of the water.
- **Do** learn to recognize floodplains and don't build a home or other structure in one. As long as floodplains are left undeveloped, flooding provides the natural benefits of replenishing soil moisture, recharging local water tables, and reducing downstream flooding and erosion.
- **Don't** let heavy cattle traffic, vehicles, or equipment damage streambanks. The soils are soft and easily disrupted, setting in motion serious erosion.
- **Don't** attempt to straighten a stream channel or cut across a meander. Although the intention may be good, generally it is illegal without a permit from the U.S. Army Corps of Engineers. It can seriously damage downstream areas due to increased water velocities and sediment.
- **Be aware** that stream problems on your land may be the result of upstream problems. If the watershed above your land is eroding, then there will be excess sediment entering your stream. If your channel bed is a rocky one, this sediment can silt in the spaces between the rocks needed by small fish, crawfish, and insects. A different problem occurs when the upstream watershed is covered by buildings, roads, and parking lots. The increased runoff from these impervious surfaces will increase the flow your stream must handle, resulting in deepening or widening of the stream channel.

Streams have an amazing ability to handle the erosive energy of flowing water, but can be made vulnerable to severe damage when a landowner doesn't appreciate how they work. By the time most stream owners notice a problem, it is usually too late for an affordable solution. Take time to enjoy and understand your stream and do what you can to protect its health.

If you are blessed with a stream, you have something of value that can greatly add to the enjoyment of a property. There is nothing quite like sitting beside a stream and taking in the sights and sounds. Both children and anglers can get a kick out of collecting crawdads, stream insects, and other stream critters. In general, streams with rocky beds and overhanging trees provide the best habitat for fish, but any stream with well vegetated banks and a riparian zone provides a tremendous benefit – they are a durable, self-repairing means of handling high flows that would otherwise erode adjacent land (Figure 6).

Figure 6. This small creek is in healthy condition with a well-vegetated riparian zone. If brush and trees are cleared, bad consequences will follow. Like most Oklahoma streams and rivers, its fate is in the hands of landowners. (Photo Credit: B. Hoagland, Okla. Biological Survey)

Glossary

Channel Bed – The bottom of the stream channel. Streams will usually have rock, sand, or silt channel beds.

Floodplain – The flat area alongside the stream channel that receives floodwaters and sediment when the stream overflows.

Habitat – The specific type of usable space, shelter (cover), food, and water required by a particular animal species. Scour holes created by woody debris and the spaces between rocks in the stream bed are important forms of usable space and shelter for fish and the insects they consume.

Kinetic Energy– The energy produced by motion. Kinetic energy is proportional to the square of velocity. Water flowing at 1 foot per second has only 1/16th of the kinetic energy of water flowing 4 feet per second.

Meander – A bend in a stream or river. Streams naturally form meanders due to erosion and deposition in the stream channel.

Mid-channel Sediment Bar – An unstable island formed by the deposition of sediment. It differs from a point bar, which is attached to an inside bank in a meander curve.

Riparian Zone – The area adjacent to a stream channel that is occupied by water loving trees, shrubs, or other plants. It generally has a greener appearance than surrounding areas.

Sediment - Sand, silt, clay, gravel, or larger rocks that have been moved by water or wind.

Sediment Deposition – The dropping of sediment from suspension whenever velocity decreases to the point that the water no longer has the kinetic energy required to transport the particle.

Silt – Sediment that is larger than clay and smaller than sand.

Snag – A dead tree. These are often valuable as habitat for fish or wildlife.

Watershed – The area of land that catches rainfall and funnels surface water and groundwater to the stream.

Further Information and Resources

Riparian Area Management Handbook, E-952 pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2251/e-952.pdf

Riparian Forest Buffers, NREM-5034 pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2227/NREM-5034web%20color.pdf

Riparian Buffer Systems for Oklahoma, BAE-1517 pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2245/BAE-1517web%20color.pdf

Ohio Stream Management Website www.dnr.state.oh.us/water/pubs/fs_st/stfs03/tabid/4159/Default.aspx

North Carolina Stream Restoration Website www.bae.ncsu.edu/programs/extension/wqg/srp/index.html

Stream Corridor Restoration: Principles, Processes, and Practices By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US government). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3. Available online at www.nrcs.usda.gov/technical/stream_restoration

http://www.floodsmart.gov/floodsmart/ – The official website of the Federal Flood Insurance Program

http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1 - On-line floodplain maps, free

http://www.myfloodzone.com/fema-flood-maps.htm - floodplain maps ($)

Stream Hydrology Models – By flowing water through a bed of plastic grit, these teaching models demonstrate normal stream functioning and then degradation under the influence of bad management practices. Six trailers are available for classroom and public event audiences. Contact your County Extension Service office.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 20 cents per copy. 0109 GH.

OKLAHOMA COOPERATIVE EXTENSION SERVICE NREM-9207

Recirculating Aquaculture Systems: Questions to Ask Before You Invest

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http://osufacts.okstate.edu

The idea of raising fish indoors where year-round growing conditions can be provided is an appealing one. Before making an investment in such a system, however, it would be wise to learn all you can about such systems. First, read this fact sheet and the others listed at the end, then visit several different indoor systems and ask plenty of questions.

The authors are cautious about the future of recirculating systems. Many individuals and corporations have lost considerable sums of money on such systems which they could not make profitable regardless of how much capital and expertise was invested. Nonetheless, breakthroughs are possible and research is ongoing at various universities and other private facilities. The following guidelines are suggested for evaluating investments in this area.

Buying A Turn-key Operation

You may be offered an opportunity to invest in a system which is reported to be successfully operating already. Claims may be made about confidential or proprietary technology. In this case you should ask for information, in writing, which documents the financial and production performance of the system:

Finances

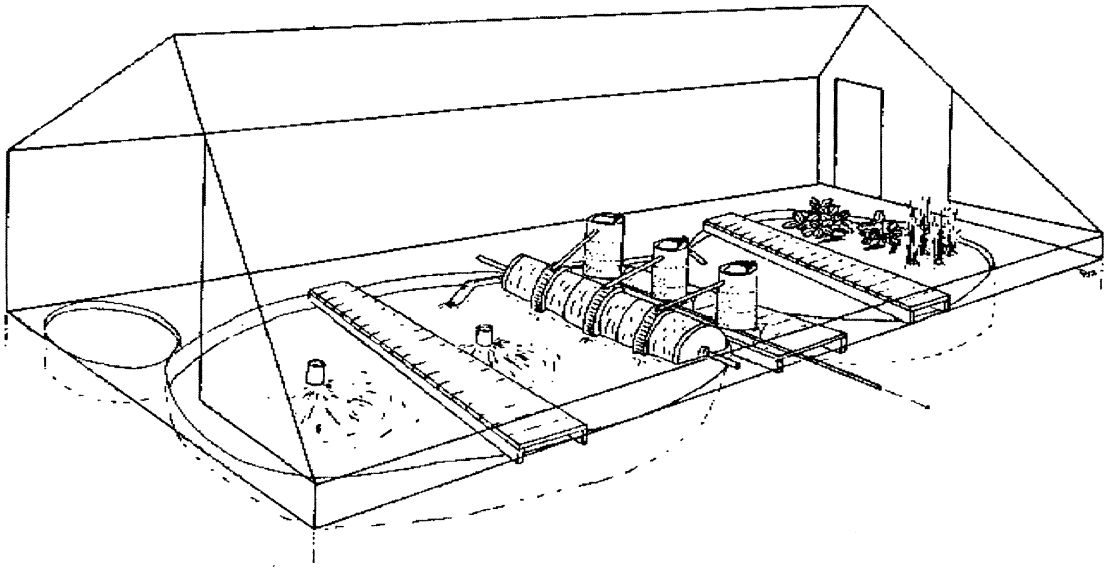
- Income statements
- Cash flow statements

To evaluate the financial soundness of the operation, historical information is needed. Copies of past and present cashflow and income statements provide information about annual growth, profitability, and stability of the operation.

Production

A complete operating history for each crop of fish produced, which includes the following information:

- Date of stocking _____
- Average fish size at stocking _____
- Date of harvest _____
- Average fish size at harvest _____
- Total amount of feed used _____
  This information will allow you to calculate feed conversion ratios and rate of gain.
- Number of fish/gallon of tank volume _____



A light stocking rate may provide misleadingly good feed conversion ratios and rates of gain which cannot be achieved when stocking rates are increased to levels needed for profitable operation.

- Volume of water in fish tanks _____
- Volume of new water added each day _____
  A system that receives a large amount of new water each day is a flow-through system, not a 100 percent Recirculating system. Flow-through systems provide more reliable conditions for fish, but it is usually prohibitively expensive to heat water in winter. Effluent water must also be disposed of in a manner acceptable under local water quality regulations.
- Number of dead fish and cause of death _____

Marketing

When starting any type offish farm, the earlier marketing plan is developed, the better. Buyers will not automatically come knocking at your door when your fish are ready for harvest. Taking the time to explore the questions below will allow you to anticipate what you must do to build your market.

- Who are your potential customers? For example, direct to consumer, restaurants, supermarkets, or wholesalers.
- What are their requirements? Including size, uniformity, number per week, live, processed, fresh, or frozen.
- How will you gain their trust?
- Who is the competition and how will you compete with them?
- What price per pound are potential customers paying now and what is your projected production cost?

In addition, it is advisable to seek legal council before entering into a contractual agreement.

Starting From Scratch

The most important piece of advice for someone intent on building his or her own recirculating aquaculture system is to begin with a small prototype. A small system will allow you to learn without going bankrupt.

A variety of problems which have plagued past attempts are discussed in the following sections. You will need to answer this question: How will your system overcome these problems?

Biofilters

Fish in a recirculating system live or die based on how effectively fish wastes are handled by biofilters. Unfortunately, biofilters are less than 100 percent reliable. The most common biofilter consists of bacteria growing on media such as plastic beads or corrugated fiberglass panels. Bacterial biofilters can die unexpectedly. They can also be killed by many of the chemicals used to treat fish diseases. Following such a biofilter "crash," two to six weeks are required before normal functioning resumes.

Another type of biofiltration involves flowing water through the root beds of plants in hydroponic systems. Uptake of nutrients by the plants varies with the growth stage and health of the plants. Balancing plant growth stages and harvesting with the biofiltration needs of the fish culture system is difficult.

Knowledge of Water Chemistry

A recirculating system manager should be able to conduct water chemistry tests, understand what the results mean and know what to do to correct problems before adverse conditions stress or kill fish. A manager who is not already familiar with or willing to learn basic chemistry concepts and test procedures will not succeed. Computer-based monitoring systems are not a substitute for a capable manager who can think quickly and act decisively to change the water chemistry.

Aeration and Plumbing Systems

Recirculating systems are unforgiving of mechanical problems. When aeration systems shut off, fish in in-door systems typically have about 10 minutes of oxygen left before they die. Automatic backup systems and pipes large enough to prevent clogging by stray fish are essential.

Economics

The cost of producing fish is usually higher in recirculating systems than in earthen pond culture. Be certain that your projected production cost will be low enough to allow you to compete with fish from other sources. A complete business plan should be prepared for this or any other major investment. The help of a neutral advisor, such as your local SBA Small Business Development Center, can be useful in preparing such plans.

Additional References

A basic understanding of how recirculating systems work can be obtained by reading the following Southern Regional Aquaculture Center (SRAC) publications. They are available in Oklahoma from the author through your local County Extension Center. Readers in other states should contact the local Cooperative Extension service office in their county. The publications include:

SRAC 451, An Overview of Critical Considerations
SRAC 452, Management of Recirculating Systems
SRAC 453, Component Options
SRAC 454, Integrating Fish and Plant Culture

Your local library may be able to help you obtain a copy of the following informative article:

Van Gorder, S. (1990). Closed systems: a status report. Aquaculture Magazine 16(5):40-47.

The Cooperative Extension Service, in Oklahoma and many other states, offers water quality short courses for fish farmers. In addition, the following SRAC publications on water chemistry are also recommended:

SRAC 462, Nitrite in Fish Ponds
SRAC 463, Ammonia in Fish Ponds
SRAC 464, Interactions of pH, Carbon Dioxide, Alkalinity, and Hardness in Fish Ponds.

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